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TRAUMATIZED &  
AVULSED TEETH**

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**In This Issue:**

**MANAGEMENT OF TRAUMATIC  
DISPLACEMENT OR LUXATION INJURIES**  
PAGE 1

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# Topics in Orthodontics Audio Series

## Casko's Corner

By John S. Casko, DDS, MS, PhD

I very much enjoyed Dr. Turley's presentation. Pat has a unique ability to organize and present material that has a scientific basis in a very practical way. I believe his dual training as a pediatric dentist and as an orthodontist gives him a unique perspective for dealing with areas of treatment such as the management of teeth that have been exposed to traumatic injury.

For a long time I have relied on the material that he has published, not only on traumatic injuries but also the use of the reverse pull facemask for the correction of Class III malocclusion. The message that I get from his presentation relating to avulsed teeth is that the timing of treatment and preventing the periodontal membrane from drying out are of critical importance. The idea of instructing a parent how to clean an avulsed tooth and replace it themselves makes perfect sense to me now that I fully appreciate how critical timing is to successful treatment for this type of injury. It is tempting to tell a parent to just clean the tooth, put it in a cup of milk, and bring it to the office. However, the time required to do this may significantly decrease the long-term prognosis for the avulsed tooth. It is also good to know that if an avulsed tooth does need to be transported to the dental office that milk is a good medium in which to store the tooth. If for some reason milk is not available, storing it in saliva is better than water.

Timing also seems to be critical if a tooth is partially avulsed or extruded. As Dr. Turley suggests, if you can treat this tooth soon after it has been

traumatized, manually repositioning the tooth back up into the socket is the treatment of choice followed by bonding a light orthodontic wire directly to the teeth and stabilizing the partially avulsed tooth. However, if the traumatized tooth cannot be replaced all the way back up into the socket, or it is a day later when a clot has developed at the apex, it is necessary to bond brackets and orthodontically align the tooth into its original pre-traumatic position. Timing in this case obviously results in two very different approaches to treatment.

It also seems to me that there has been a philosophical change over time in the treatment of both displaced teeth and condylar fractures. In the past I believe most clinicians would have adhered to a philosophy of applying rigid stabilization or fixation. Dr. Turley has made it clear that in some of these instances it is more important to allow for some mobility. If a tooth is solidly in a traumatically intruded position, it may require an oral surgeon to luxate it prior to repositioning it. With condylar fractures, it also seems that maintaining mobility and establishing normal dental relationships and function is critical.

The other thing that I am always impressed by is the ability of nature on its own to solve problems. Sometimes I think that if we did not interfere with nature, we would have much higher success rates in many of the things that we do. I would like to thank Dr. Turley for this very scientific and practical presentation and for many of the other contributions he has made to benefit our specialty.

## Management of Traumatic Displacement or Luxation Injuries

By Patrick Turley, DDS, MSD

The management of traumatic displacement or luxation injuries in the mouth should be the responsibility of the orthodontist. There are a number of reasons for this. First of all, a lot of these patients are of an orthodontic age and may even have orthodontic appliances in their mouth. When a traumatic injury occurs, the orthodontic appliances are often damaged. The orthodontist is commonly the first person contacted. We are also the individuals in dentistry that are most adept and most experienced with the current splinting techniques, which usually involve the direct placement of light orthodontic wires or the placement of brackets with light orthodontic wires.

With a partial avulsion, described as an exclusive luxation injury, where the particular incisor is extruded four to five mm, and the injury has occurred within the last couple of hours, digital or hand repositioning the tooth back up into the socket is the treatment of choice. Then you can simply stabilize that tooth by bonding a light orthodontic wire directly to the teeth. However, if you cannot get the tooth all the way back up into the socket, or it is 24 hours later and a clot has developed at the apex, then you would want to bond brackets and then orthodontically re-intrude that tooth back up to its pretraumatic position. In the extrusive injury the tooth can usually be gotten back up most of the way.

Other injuries are what we describe as lateral luxation, where the crown has been driven to the palate. The apex of that tooth often pops out to the labial, and that particular injury usually cannot be repositioned without local anesthesia. With extrusions, you can get those teeth back up most of the way without anesthesia. The patient will bite on a cotton roll, and in 10 or 15 minutes the tooth may be all the way up.

The fractured root, in my experience, is an infrequent occurrence and seems to occur in the older child. In the younger ones, less than 10 years old, who have more pliable bone, the bone usually gives way or the tooth gives way first. An x-ray is needed to see what that root looks like.

#### Light vs Rigid Stabilization

Root fractures are the one type of injury where rigid stabilization is recommended. In most injuries, we want the periodontal ligament to heal, and light wire stabilization allows some flexibility, which allows the periodontal ligament to reheel. When you want hard tissue healing, as with a broken bone, then that is when you want rigid stabilization. The root fracture is where you would like to see some new secondary cementum being laid over the fracture site and hopefully rejoin the two segments. That is when we would rigidly stabilize it. Most of the time you get a fibrous union. The root fracture is the one that we still rigidly stabilize, even though we do not know if it is helpful or not.

In the case of the root fracture, the apical segment almost always maintains its vitality. The coronal segment may or may not depending on a number of factors, such as how far the coronal segment was displaced and when you reposition it. It does not necessarily mean it is going to need endodontics. However, in just about all of these moderate to severe injuries, I like to get the endodontist involved. After I am finished stabilizing the tooth or moving it, I send the patient to an endodontist within a couple of weeks. It does not mean that there will be any treatment done, but I sure want the endodontist to follow the case. Many of these cases will develop loss of pulpal vitality as well as one of the three types of root resorption. This requires endodontic treatment to stabilize the root resorption process.

#### Surface Resorption, Replacement Resorption, & PCO

There are basically three types of root resorption that occur following a luxation type injury. The first type, the surface resorption, is like orthodontic resorption. The tooth has been traumatized and the periodontal ligament has probably been compressed or torn. That periodontal ligament responds by producing cells, which then resorb the alveolar bone, remodel it, and remodel the root, similar to orthodontics. But that type of resorption is limited. It is actually repairable and is not a long-term problem. But in the more severe injury, especially the avulsion injury, you can get an inflammatory type resorption, which is very rapid. It destroys a root structure very quickly, and it needs very timely intervention by the endodontist. There can also be a slower type of resorption that we call replacement resorption, which is the resorption that is associated with ankylosis that occurs over months and years. This is where the root is being slowly resorbed and replaced by bone and then the tooth ankylosing. The treatment for both of those is actually to remove the pulp, which does not seem logical. The pulp is removed, and then calcium hydroxide is placed in the pulp. The calcium hydroxide actually leaks through the dental tubules into the damaged periodontal ligament and can help the healing process. Inflammatory resorption is actually treated quite well in this regard. Once replacement resorption starts, the endodontic treatment is not too successful, but we still jump in there and remove the pulp and get the calcium hydroxide in there.

Sclerosis of the canal, which is referred to as pulp canal obliteration (PCO), can occur. We see that mostly associated with the more severe injuries in teeth that still have an open apex. A tooth that is intruded in a seven-year-old with an open apex may eventually develop PCO. Whereas, that same injury in a 13-year-old with a closed apex would develop pulpal necrosis. Only about seven to 15% of teeth that develop pulp canal obliteration will develop endodontic problems. The recommendation is not to prophylactically go in there and do endodontics on those teeth but simply to monitor them and watch the progression of the pulp canal obliteration, which is not necessarily a bad thing. It is actually a byproduct of the healing process. The pulp is trying to heal itself, but in the process it is producing different types of cells that are now laying down hard tissue on the inside of the pulp canal.

When the child fractures the condyle in a traumatic injury, we do not wire the jaw shut so that the condyle can heal. Without any mobility, ankylosis of the joint is more likely to occur. Therefore, we want some flexibility in there, which encourages the production of soft tissue or collagen. Some slight mobility with function, chewing, but being stabilized with a light wire allows the production of collagen, which then contributes to the healing process of the periodontal ligament without ankylosis occurring. We have found that rigidly splinting those injuries actually promotes the development of dental ankylosis.

Years ago we used to leave the splints on for about six weeks. Again, thinking of the analogy of the broken leg with the cast, everything had to be rigid, and it had to be six to eight weeks for healing. We are not only doing these in flexible terms today, but we are leaving them for a much shorter period of time, seven to 14 days depending on the severity of the injury in terms of how mobile it is. Usually, we are trying to get these teeth back into function once the acute phase of the injury and the healing process is started. We are removing these early and allowing them to get back and function so that the periodontal ligament can heal itself. The exception might be with the root fracture. It is going to be rigidly splinted and left on for a longer period of time, monitoring it with x-ray to see if there is hard tissue union occurring across a fracture site.

If we have a tooth that is extruded four to five mm out of the socket, and the injury occurred 24 hours prior, you are going to have a clot that has developed at the apex of that socket. You are not going to be able to manually reposition that tooth back up. In fact, it is contraindicated. The studies have shown that you will produce more complications. Therefore, rather than putting on a light wire splint, we are going to orthodontically re-intrude that tooth using light wires and brackets like we normally would. Therefore, we would be placing brackets the next day, maybe just on the six anteriors, and then using a light wire to relevel that tooth. We would be doing the same thing if the tooth was driven towards the palate, if the coronal aspect of the tooth was now driven in the crossbite. We would place brackets and then a light archwire to move that tooth back out. In the case of the anterior crossbite, if you have some overbite, you may need to open the bite up in the back, too, with a bite plate or some temporary bite opening mechanism.

Consider how soon after a traumatic intrusion the tooth should be activated orthodontically in order to realign or extrude it. The intruded injury is a very difficult one. This is where the tooth has been driven to the alveolar bone. The periodontal ligament has now been compressed or actually

obliterated. There is probably some alveolar fractures because as a tooth has been driven in the alveolar, it has to spread in order to accommodate the tooth. That tooth now is set up to develop ankylosis because there is no periodontal ligament, it has been crushed. The treatment then depends on the severity of the injury. If the tooth has some mobility, mobility meaning similar to adjacent teeth, and the amount of the intrusion is minimal to moderate, maybe up to four mm, you will be putting brackets on and immediately trying to level out or extrude that intruded tooth. Immediately means that if it is a Saturday, you do not have to do it on Saturday, but I would have them back on Monday. We did some animal studies back in the 80s that showed that ankylosis will occur within seven days in that situation. Therefore, you need to start moving that tooth away from the alveolar bone and making a periodontal ligament space as soon as possible. If the tooth is solid in that new intruded position, and there is no mobility, the tooth needs to be luxated first. We usually get it to a surgeon. It requires a local anesthetic. They put forceps on it, and they wiggle it a little to get it plus one mobility. The purpose of that is to reestablish some periodontal ligament space and bring the tooth down a little. If the tooth is totally intruded where you cannot even see the crown, and that happens once in awhile, the surgeon may need to not only luxate it but extrude it a little for you so that you can get the bracket on it. You are going to start realigning that tooth immediately.

Most intruded teeth will develop pulp necrosis. In fact, if the apex is closed, when we are talking about patients who are 11 years old and older, about 100% of those are going to develop pulp necrosis. Two-thirds of those with an open apex will develop pulp necrosis. Therefore, you want to get them to the endodontist as soon as possible, within two weeks. If the apex is closed, we recommend actually having the pulp removed prophylactically, and then get calcium hydroxide in there before root resorption and ankylosis have a chance to establish themselves.

#### When the Tooth Is Knocked Out

If the parents report that a tooth has been knocked out, then first ascertain where the tooth is. If they do not have the tooth, have them go back and search the area where the tooth was lost. If they have the tooth, our objective is to get that tooth back into the socket as soon as possible. Every minute that the tooth is out of the socket drying reduces our long-term success.

We would like to find out if the parent is emotionally and physically able to put the tooth back up into the socket, and whether the child is cooperative or not. If so, then we are going to explain to the parent how to put the tooth back up into the socket. First of all, find out if it is clean or had it been knocked out at home plate and is now covered with dirt. If it is dirty, we want them to lightly rinse it off with water at the sink. Make sure they put a strainer or a rag over the drain. We do not want them scraping it because they will scrape the periodontal ligament fibers off of it. If it has some grass on it or something, they can sure lightly pick those things off. Rinse it off, shake it off, and try to get the dirt off. Next, ask if they can tell you the difference between the front of the tooth and the back of the tooth. We need to make sure we are putting the tooth in with the correct side facing out. Instruct the parent to start placing the tooth up into the socket and then gently push it up. Usually, you can go a good distance without there being too much discomfort for the patient. If they can get it within a couple of millimeters of its original position, then you can have the patient hold it in place with a rag or a tea bag or something. Now that the tooth is in the socket, we are going to instruct them to get in the car and drive to the office.

If they are not able to get the tooth into the socket, they feel uncomfortable, or the child is not cooperative, then we want them to put the tooth in a little cup of milk. If it is being transported in milk, it is not quite so bad, but my preference is to have that tooth back up into the socket immediately. In only a minority of cases have I had parents feel that they "just could not" put the tooth back into the socket.

There have been some studies on why to use milk. Of course, water physiologically is not the same as saliva. The pH is not the same. Therefore, the periodontal ligament will be damaged over a period of time in water. But believe it or not, they have done studies on this and soft tissue can survive up to six hours in milk at the same level that it would survive in tissue culture mediums or in balanced salt solutions. Milk is very physiologic, and it seems to be an excellent storage medium over a short period of time, up to six hours. The worst thing you can do is have the tooth dry. If there is no milk, water is better than having it dry out, and having it in saliva is better than water.

Once they are in the office, the orthodontist is going to reposition the tooth back up into the socket, and get it up as far as he can, then place light wire stabilization. We then send the patient immediately to the endodontist. Most of these teeth that are avulsed are going to lose pulp vitality. But if the tooth has been reimplanted within a few minutes, we have a good chance of maintaining periodontal ligament vitality, which is the most important thing. We all know teeth can have root canals and survive for decades.

#### Avulsed Teeth & Chances of Survival

The majority of avulsed teeth will require endodontic treatment, but it is going to depend on the stage of root development. Survival of these avulsed teeth depends on a number of factors. The first factor is the extraoral period, especially the amount of time that the tooth is out of the mouth and not in a proper storage medium. The second factor is the stage of root development. Teeth with open apices will have a greater chance of maintaining pulp vitality if we get them back in soon. The third factor is the type of stabilization used, rigid versus flexible. If we can get these teeth back into the mouth within a short period of time, within a number of minutes, the incidence of replacement resorption or inflammatory resorption will be low. If the tooth has an open apex and you can get it back within a couple of minutes, you may even maintain pulp vitality because of the open apex being much better at revascularizing itself. If the tooth has been out only a couple of minutes and it is a closed apex, you are probably going to lose pulp vitality, but the periodontal ligament will heal adequately. In a tooth that has been out of the mouth a half an hour and has been drying, periodontal ligament healing now is going to be really compromised, and if it has been out drying for an hour, you can almost bet that the tooth will not survive long term. It will ankylose eventually and undergo replacement resorption.

If we were looking at the extrusive injury that we talked about before, pulp survival rates are 90% with a wide open apex. Most of those extrusive injuries in young children will have no problems. With a closed apex, it has about 50/50 chance of survival. About half of those teeth will eventually lose pulp vitality and half will not. When that happens, are we talking within a year or two years? That is a harder question, and I do not know the answer to it. If the tooth has been previously traumatized, there is a chance that you can lose pulp vitality during orthodontic treatment. Therefore, that is a standard question on our dental history forms. With teeth that have an extraoral period of over an hour drying time, those teeth do not have a good long-term prognosis.

Studies have shown that teeth that have endodontic treatment actually show less resorption with orthodontics. Is that not interesting! There is something about having a vital pulp that actually is a contributor to the development of root resorption during orthodontic treatment.

If the tooth is avulsed, is reimplanted, the patient gets to the endodontist in two weeks, and inflammatory resorption is starting, the endodontist removes the pulp and puts the calcium hydroxide in. Now you are waiting a number of weeks for the inflammatory resorption to resolve itself, which it usually will. The inflammatory resorption may heal, but you may end up developing the replacement type resorption. The problem with replacement resorption is it is so slow and progressive that it takes you a number of months, maybe even a year or more, to see how far it is going to progress. Usually once replacement resorption kicks in, and that is the type where the root starts to look somewhat mossy, and you do not really see a defined periodontal ligament space anymore. Once it sets in, it is usually a slow, progressive process. Then the question is, do you keep the tooth for a period of time for aesthetic purposes or space maintaining purposes, or do you want to go ahead and extract it and try and do some other things? It is a difficult decision, but I think it needs to be made by both the endodontist and the orthodontist together.

#### What About Condylar Fractures?

Given a suggestive injury, patients with condylar fractures need to get x-rays, not only of the dental area but any other areas that were suspect. A good Panorex, of course, would be important, especially if the child has some tenderness in the TM joint area or they are showing some sort of occlusal disharmony or some asymmetry. It is possible that there could be a condylar injury. I have seen a number of these over the years where the condyle was fractured, and it was missed by the professionals that saw the child on a Saturday. Therefore, you want to make sure you get good x-rays. If you have a condylar fracture, then what do you do about it? Generally, these are not injuries that require surgical intervention. They are shown to contribute to further development of problems, such as scarring, ankylosis, and other problems. The treatment, then, depends on whether the mandible has repositioned itself. We commonly think of the mandible developing deficient growth after a condylar injury. Studies have actually shown probably more than 50% actually will develop a class III on that side. But the important thing is whether the child has a normal occlusion or not. If they can

still bite with their midlines, then I think treatment includes putting them on a soft diet and basically monitoring the function of the mandible and the joints. Also, you will want to radiographically monitor the healing of the joint. If they have an asymmetry following the injury, with either a class III or a class II discrepancy now showing itself where they did not have it before, you may want to intervene with some active treatment. For example, I have used a Morrow type appliance or a Herbst on the side of the fracture where the mandible was displaced distally. I have used a twin block to keep the mandible centered. I have also had patients with a posterior crossbite, the mandible shifted to one side, and a class III on that side. In those situations, I have actually put on full braces the following week and put them on intermaxillary elastics to bring the mandible back into the center and reestablish a class I occlusion. It is important to get good radiographs and a good diagnosis. Then, depending on whether the mandible is in normal position or not, I institute whatever may be necessary to get the mandible back in its normal position. However, with function, it is important not to wire the jaws shut in a growing child. Allow them to function so that the joint is not going to ankylose and the soft tissues can heal themselves as well as the condyle.

In the event that there is the crossbite to one side, such as when the mandible shifts to the right four mm, then they are class III. You are putting on braces, bonding brackets, and then putting them on elastics. You want to make sure you are not wiring them shut with those elastics. You do want some flexibility so that that patient can function, can open and close while you are walking that mandible back to its normal position. You do want mobility. You do want development of normal function.

The problem with these injuries, especially the condylar ones, is that we do not see them that often. We are almost flying by the seat of our pants. I have not seen a study that has examined 50 condylar injuries and how many of those healed with the condyle looking normal later versus how many healed without. I have had it occur on both instances. I have had the condyle at a 90 degree angle towards the medial, and three years later that condyle has re-erupted itself and has uprighted. I have had it where the condyles remained out of the fossa, and the fossa remodeled itself. It does not look like the opposite side, and yet, the patient seems to be functioning adequately.

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Drs. Casco, Sarver, and Turley reported no conflicts of interest related to this activity.

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